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The experimental study of cultural transmission: A pilot study on when and who people copy

Dr. Luke Rendell

University of St. Andrews
Centre of Social Learning and Cognitive Evolution
School of Biology
St. Andrews, Fife, United Kingdom KY16 9TS

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Culture influences behavior, and the way cultures change over time profoundly affects the way people's behavior changes. Cultural evolution – the change in the content of a given culture over time – is based on individual choices, whether it is what music people choose to listen to, whether people choose to adopt the latest technology or whether they absorb the tenets of violent fundamentalism. Unfortunately, scientists chronically lack evidence on how human psychological biases affect cultural evolution. In this research we have attempted to address this problem by experimentally probing the conditions under which people are more likely to turn to social information over their own existing knowledge or beliefs, and when they do, which kind of individuals are more likely to be chosen as information sources. Given the huge impact even a single, fanatically motivated individual can have in the era of modern terrorism, understanding the factors that lead individuals to be influenced toward and away from certain behavior patterns is essential strategic knowledge in any effort to reduce the influence of violent fundamentalism. This research provides an opportunity to begin creating essential foundational knowledge for the understanding of cultural change built by the choices of many individuals.

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The experimental study of cultural transmission: A pilot study on when and who people copy

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FINAL REPORT

Luke Rendell[1], Lynda Boothroyd, Rick O'Gorman, William Brown and Jerome Barkow

[1]Corresponding author: ler4@st-andrews.ac.uk

Table of Contents

Summary

- There is little empirical data on human social learning with which to test hypotheses generated by evolutionary models
- We investigated whether attractive faces were associated with more influential social information
- We tested how the response to incorrect social information varied across three conditions: (1) *no faces*, where social information was presented with no facial stimuli, (2) *unbiased faces*, where social information was presented with faces but no attractiveness bias, and (3) *biased faces* where the faces choosing the incorrect response were always more attractive (as rated by 10 independent raters) than those choosing the correct option.
- In the *no faces* condition, subjects were more likely to follow incorrect social information when it was associated with consensus (4|0>6|2>8|4).
- In contrast, in the *unbiased faces* and *biased faces* conditions, subjects appeared more likely to follow a majority opinion when it was associated with greater numbers of demonstrators (8|4>6|2>4|0).
- We could not detect any difference in response rates between the *unbiased* and *biased faces* conditions.
- Our results suggest that people alter the way they use social information dependent on the context in which it is presented. When associated with facial stimuli, subjects appeared to regard information from larger numbers of people as more reliable, even when there were relatively low levels of consensus.

Introduction

Culture influences behaviour, and the way cultures change over time profoundly affects the way people's behaviour changes. Cultural evolution – the change in the content of a given culture over time – is based on individual choices, whether it is what music people choose to listen to, whether people choose to adopt the latest technology or whether they absorb the tenets of violent fundamentalism. While this may be self-evident, understanding what makes people copy others, and when they do, what affects who they copy, is not evident at all. The acquisition of new cultural behaviour by individuals is founded on *social learning*, a term which incorporates all learning influenced by social interaction with conspecifics. In order to understand how culture changes over time, it is essential to understand the psychological parameters that underlie social learning and cultural transmission. Theoretical considerations predict that evolution should have shaped *social learning strategies* – heuristics or rules describing when and who to copy – in both animals and humans (Laland, 2004). These rules that govern use of social information are also variously referred to as "transmission biases" (Boyd and Richerson, 1985, Henrich, 2001), and "trust" (Harris, 2007). Recent animal experimentation has backed up this prediction by showing that, for example, fish and rats are indeed selective about how they use social information in order to inform their behaviour. There is every reason to expect that humans are equally, if not more, selective in how they use social information. The biases that these strategies may introduce to cultural transmission will profoundly affect how information flows between individuals, and thus how those individuals subsequently behave, and by extension how cultures change on a large scale.

Social learning strategies have been primarily examined through theoretical work using population genetic and game theory models (Boyd and Richerson, 1985, Cavalli-Sforza and Feldman, 1981, Rendell *et al.*, 2011, Rogers, 1988, Schlag, 1999, Schlag, 1998). Such rules are also receiving attention from researchers in a wide variety of academic disciplines with interests in the experimental analysis of social learning, cultural transmission and cultural evolution (Efferson *et al.*, 2008, Kameda and Nakanishi, 2003, McElreath *et al.*, 2008, Mesoudi, 2008, Morgan *et al.*, 2011). However, there remains comparatively little empirical data on human social learning with which to test the hypotheses generated by evolutionary models.

One relatively well-studied class of rules are frequency dependent strategies, such as conformity, which involve individuals selectively adopting traits based on how common they are. Following Boyd & Richerson (1985, p.206), we define conformist frequency-dependent copying as the disproportionately likely adoption of the most common variant. Theoretical work on conformity has produced mixed results; some analyses suggest that conformity readily evolves under a broad range of conditions, including temporally and spatially variable environments (Henrich and Boyd, 1998), whilst others models conclude that conformity should be selected against because it hinders cumulative culture (Eriksson *et al.*, 2007). Empirical evidence of conformity has proven elusive (Claidière *et al.*, 2012, Eriksson *et al.*, 2007), and some work has suggested that changes in frequency may be more salient than absolute frequencies (Toelch *et al.*, 2010).

Another class of social learning strategies are pay-off based rules, where copying depends on the return to the observed individual (Kendal *et al.*, 2009). Game-theoretic analyses have indicated that strategies where an individual's use of social information was proportional either to their own pay-off, the pay-off to demonstrators, or the difference between the two can be particularly effective (Schlag, 1999, Schlag, 1998). There is good evidence that humans and other animals are sensitive to such information and do use it to direct social learning (Apesteguia *et al.*, 2007, Mesoudi, 2008, Pike *et al.*, 2010). Other types of strategy are less studied, but nonetheless there is evidence from human populations that adaptive beliefs are transmitted via prestige (Henrich and Gil-White, 2001) and kinship biases (Henrich and Henrich, 2010).

There is, of course, a long-standing interest amongst social psychologists in when individuals will adopt the decisions of others [33-40]. Social Impact Theory clearly relates to social learning strategies, proposes a psychological mechanism and has been extended to consider its effect upon population level belief patterns [37, 41]. While there is a long tradition of these studies in social psychology (Bond, 2005), the new wave of research is different because it is rooted in the formal evolutionary theory described above (Mesoudi, 2009). Thus while social psychology can provide immediate descriptions of the way people use social information, the more recent research on social learning strategies seeks to link such observations with functional evolutionary explanations (Mesoudi, 2009). We aim to understand not only how different factors affect decision making, but also their impact upon individual performance, leading to functional explanations for the evolution of decision-making rules. We chronically lack evidence on how human psychological biases affect cultural evolution. We attempt to address this problem here by experimentally probing the conditions under which people are more likely to turn to social information over their own existing knowledge or beliefs, and when they do, which kind of individuals are more likely to be chosen as information sources. Given the huge impact even a single, fanatically motivated individual can have in the era of modern terrorism, understanding the factors that lead individuals to be influenced toward and away from certain behaviour patterns is essential strategic knowledge in any effort to reduce the influence of violent fundamentalism. This research gives the Air Force an opportunity to begin creating essential foundational knowledge for the understanding of cultural change built by the choices of many individuals.

The initial phase of the project concentrated on establishing a robust experimental protocol. We chose to investigate, as a demonstration of the experimental technique but also an interesting research question in its own right, whether attractive faces were associated with more influential social information. This follows from the arguments of Barkow et al., (in press), that the kinds of things that draw our attention in the social information context may have been exapted from attention attractors that function in other domains – in this case, mate choice, where people have been shown to be very sensitive to facial attraction cues (Boothroyd *et al.*, 2007). If this hypothesis were true, then we would expect people to be more likely to follow social information if it was presented as representing the choices of people with attractive faces, than if no such bias exists. At the same time, the presence of faces alone, with no attractiveness bias, could alter the way that social information is perceived, in a way that is important for scientists

in the field to understand, as virtually all the experimental studies do not include these kind of stimuli when presenting social information.

Methods, Assumptions and Procedures

We set out in this study to understand how the presentation of social information influenced the extent to which subjects would elect to follow the majority verdict under three conditions – a baseline in which social information was presented without facial stimuli, one in which social information was presented with facial stimuli representing the choices made by others, and a third in which facial stimuli were coupled with an attractiveness bias toward the majority (i.e. the faces of the majority were higher than average attractiveness and those of the minority of lower than average). From hereon, we refer to these conditions as *no faces*, *unbiased faces*, and *biased faces* respectively. We used the software Millisecond Inquisit® to code and present the experiments.

Mental rotation task

Subjects were required to decide whether two shapes were the same shape seen from different angles or different shapes (Figure 1). This task was based upon on that used by Shepard & Metzler [49], and allows trials of different difficulty to be generated. In each trial, subjects received a single visual presentation of an image of two shapes, for four seconds, and were asked to decide whether the shapes matched or did not match. This presentation forms the asocial information that subjects in all phases were presented with. We used 32 shape pairs, randomly selected during trials, with varying shape complexity and degree of rotation to ensure a range of task difficulty. Shape pairs were divided equally between matching and non-matching pairs, and subjects in all phases were presented with equal numbers of both. Subjects did not receive feedback on their success during any part of the experiment, to avoid conditioning effects.

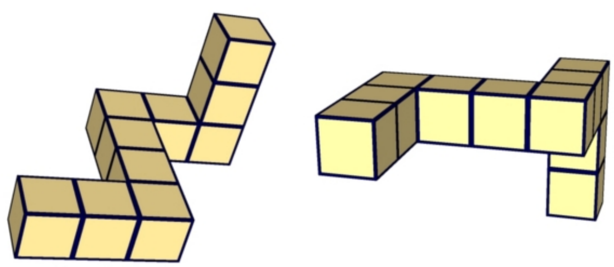

Figure 1: Example of mental rotation task. In this example the shapes match, but are rotated through 160 degrees.

Collection of facial stimuli

Faces of male and females students at Durham University were photographed using digital cameras; if they indicated on their consent forms that they gave permission for their images to be used in experiments then they were carried forward into the experiment; this gave 95 faces in total. These faces were then masked (removing most of the hair and any portion of the individual's clothing from view; Figure 2). These stimuli were then all rated for attractiveness on a 7 point likert scale by 10 different paid raters (again males and females), and each image assigned the average score of the ten.

Figure 2: Examples of masked facial stimuli.

Collection of genuine social information

The use of a conditional information lottery to present manipulated social information without the need to deceive subjects about its presence requires that some of the information presented be genuine i.e. be the actual responses of real individuals to the same task as faced by the subjects. To collect this, we asked a subset (43) of the individuals whose faces we used to also provide their best answers in response to all 32 of the shape-pair stimuli described above, with the payment of a performance related bonus used to motivate them to answer as best they could. Their answers were then linked to their faces, so that there actual choices could be presented. In the *no faces* condition, their answers alone were used.

Social learning tests

For the main part of the experiment, we used 100 subjects, all students at St Andrews, Essex, and Bedford Universities. Experimental sessions lasted for 60 minutes. Subjects were paid £5 for taking part, plus a bonus of up to £10 dependent on their performance, to motivate performance at the mental rotation task. In this experiment subjects completed 26 trials, in random order, with each trial consisting of four phases: (1) Presentation of asocial information, a 4 second showing of a pair of shapes, as above (in half the trials they matched, in half they did not), (2) Querying the subject whether they thought the shapes matched or not, and their confidence, on a 7-point Likert scale, in their answer, (3) Presentation of social information (of varying quantities across trials, see below) and finally (4) Querying a second time whether the subject thought the shapes matches and their confidence in their final answer (subjects were reminded of their initial answer at this stage).

The manipulated social information was presented in one of 4 treatments in each trial, with the numbers choosing each option being either 4|4, 4|0, 6|2 and 8|4. These treatments

were devised to cross-cut two potential learning strategies – preference for consensus (4|0>6|2>8|4) would produce effects in the opposite direction to preference for larger amounts of social information (4|0<6|2<8|4). Where a majority or an attractiveness bias existed, it was always in favour of an *incorrect* answer (i.e. 4|0 representing 4 choosing the correct option and none the wrong one). Each treatment was repeated with matching and non-matching shape pairs, making 8 trials for each condition, and across all three conditions (*no faces*, *unbiased faces* and *biased faces*), giving 24 trials. The remaining two trials used genuine social information, making up the 26 trials, and forming the basis of a conditional information lottery protocol, where genuine social information is presented in only one of a series of trials, but subjects are not informed at to which one; the other trials present experimentally manipulated information. Such a protocol means that we did not need to deceive subjects about the presence of manipulated social information, an important consideration for a programme of repeated experiments. Subjects were paid a financial reward based on how many times they got the answer right after the presentation of social information, in only those trials where, though no identified as such, the social information was genuine. These trials were then discarded from further analysis. The conditional lottery approach was explained in the experiment briefing, and experiments have shown that people behave in that situation as if all information, manipulated or genuine, was in fact genuine [50]. Subject feedback following the experiment was used to identify subjects who had failed to understand this procedure and their data was excluded from analysis.

Social information was presented on a screen displaying the two possible answers side-by-side (‘the shapes match’, ‘the shapes do not match’). In the *no faces* condition, a choice was represented by the relevant answer inverting colours for 1 s; in both conditions with facial stimuli, then choices were represented by a face appearing above the relevant answer, again for 1s, considered ample time for attractiveness judgements to be made by either sex (van Hooff *et al.*, 2010). Average attractiveness ratings of the facial stimuli ranged from 1.9 to 5.0, and in the *biased faces* condition then the majority facial stimuli were chosen from those faces with ratings greater than the mean plus one half the standard deviation, and the minority from those rated less than the mean minus one half the standard deviation.

Subjects took part in experiments in batches of 1-11 individuals. All subjects had access to a computer and were separated by large screens such that they could not see other subjects.

Data analysis

We expressed the subject responses in two ways. Firstly, as the proportion of those trials in each social treatment where the subject answered correctly after asocial information only in which the subject then switched to the incorrect answer after viewing social information. That is, the proportion of subjects who switch from the right to the wrong answer after social information favouring the wrong answer, in number and, in the *biased faces* condition, in attractiveness. Secondly, we calculated the change in subject confidence before and after receiving social information conflicting with their initial, correct, choice, reasoning that even if they stuck with their initial choice then any change

in confidence could also reveal how the conflicting information was influencing subjects. We modelled these data using generalised linear models (GLM) with binomial and normal error respectively. Models were constructed with treatment coding to contrast (a) responses to different social treatments, tested against the 4|4 basline, within experimental condition and (b) responses across experimental condition with social treatment, comparing first *unbiased faces* against a *no faces* baseline and then *biased faces* against an *unbiased faces* baseline. Data analysis was carried out in Matlab®.

Results and Discussion

Probability of switching from correct answer after social information

With responses measured in this way, a clear pattern emerged in the *no face* condition, with, unsurprisingly, very little switching in the baseline 4|4 social treatment. Compared to this baseline, there was significantly more switching in both the 4|0 (also the treatment with the maximum level of switching) and 6|2 condition, but not in the 8|4 condition. This suggests that people are more likely to switch when social information shows a higher degree of consensus (8|4 is the most 'divided' information), and this effect overrides the simple amount of social information. Thus subjects appeared sensitive to consensus when no faces were presented (Figure 3; Table 1).

In contrast, in the *unbiased faces* condition, subjects appeared more sensitive to the amount of social information than in the degree of agreement it represented (Figure 3; Table 1), with effect size and significance increasing with increase number of facial stimuli shown rather than degree of consensus. This is a very interesting contrast, apparently showing a complete reversal of the strategies of social information use when social information is impersonal (i.e. *no faces*) and when it is personal (i.e. *unbiased faces*).

Thirdly, in the *biased faces* condition, there was no clear trend to prefer either consensus or amount of information (Figure 3; Table 1). Although switching rates were increased compared to the baseline in all three social treatments, two of them significantly so, the rate did not appear to vary appreciably across the three social treatments in which there was a majority opinion.

When comparing across conditions within social treatment, results were more unexpected. We anticipated that the presence of faces might make social information more salient, and therefore more likely to be followed, compared with the *no faces* baseline. In fact, this was not the case – in two of the three non-baseline treatments the rate of following social information was significantly *lower* than in the absence of faces (Table 2). The lack of apparent difference in the 8|4 condition appears more related to the declining salience of more divided social information in the *no faces* condition than any variation in switching rates in the *unbiased faces* condition. The addition of an attractiveness bias appears to make very little difference to this result, as for none of the social treatments were the switching rates significantly different in the *biased faces* condition than in the *unbiased faces* condition (Table 2). In the 4|4 treatment, where an attractiveness bias is

the only cue to any preference in the social condition and thus would be most evidence, there is only a very small (and insignificant) change in the switching rates, albeit in the positive direction, across the conditions.

Figure 3: Proportion of switches to follow incorrect social information in varying quantities in three conditions (No faces, Faces with no attractiveness bias, Faces with attractiveness bias)

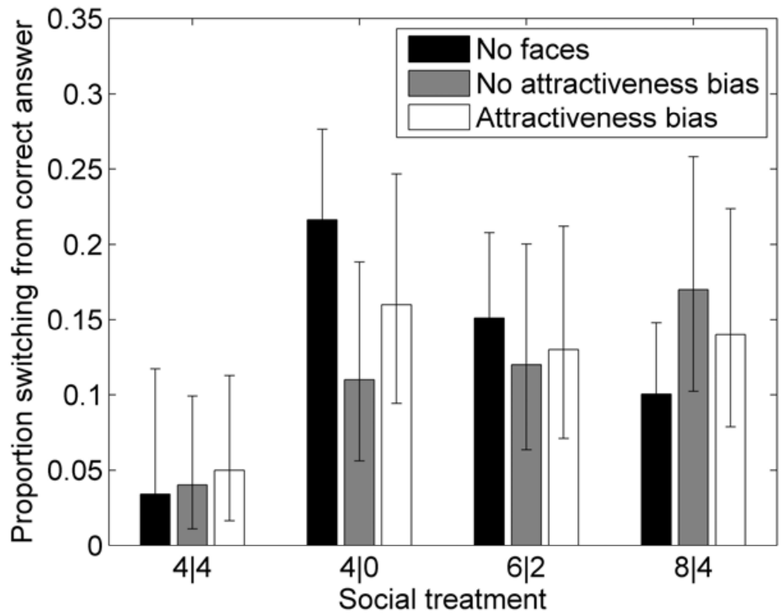

Table 1: Binomial GLM results comparing responses to different social treatments by experimental condition (Beta gives parameter estimate on logit scale, *p* gives significance)

	No face stimuli		Unbiased face stimuli		Attractiveness biased stimuli	
Treatment	**Beta**	***p***	**Beta**	***p***	**Beta**	***p***
4|4	Baseline	-	Baseline	-	Baseline	-
4|0	2.0620	0.0052**	1.0873	0.0710	1.2862	0.0160*
6|2	1.6248	0.0293*	1.1856	0.0466*	1.0435	0.0563
8|4	1.1577	0.1245	1.5924	0.0057**	1.1291	0.0372*

Table 2: Binomial GLM results comparing responses within social treatments across different experimental condition.

	No face vs Unbiased faces		Unbiased faces vs Attractive biased faces	
Treatment	**Beta**	***P***	**Beta**	***p***
4|4	0.1719	0.8455	0.2336	0.7335
4|0	-0.8029	0.0252*	0.4325	0.3033
6|2	-0.2674	0.0293*	0.0915	0.8307
8|4	1.1577	0.4630	-0.2297	0.5583

Change in confidence following social information
The pattern observed in the switching rate data was not clearly repeated in the analysis of the change in subject confidence following a correct answer and conflicting social information (Figure 4; Table 3). Although the social information had a negative effect in all non-baseline social treatments in the *no faces* condition, none of the effects were big enough to achieve significance under the given sample size and there was no clear trend indicating whether consensus or amount of information was the most important factor.

In the *unbiased faces* condition, all social information resulted in a drop in confidence, even in the 4|4 baseline treatment, and in the 4|0 and 8|4 conditions this drop was significantly greater than that in the baseline treatment, but not in the 6|2. Apparently the presence of facial stimuli again alters the response to social information, seemingly making subjects more prone to loss of confidence. We saw a very similar pattern in the *biased faces* condition, with little evidence of a systematic preference for consensus nor of a preference for more social information.

Comparing conditions within social treatments, we see that although in the 4|4 condition, the presence of faces does appear to induce a negative effect on confidence, and the existence of an attractiveness bias appear to further reduce confidence, this change is not large enough to be detected significantly under this sample size, so it does not appear to be major. In 2 of the three non-baseline social treatments, 4|0 and 8|4, the presence of facial stimuli has a large negative effect on confidence compared to the *no faces* condition, again indicating that the presence of faces negatively effects confidence in asocial judgements. In contrast, the addition of an attractiveness bias makes no significant different in any social treatment, although in the 4|4 treatment where this effect would be most apparent, confidence appears to fall 50% more than in the unbiased condition, there is clearly so much individual variability around this that the effect is not significant.

Figure 4: Change in confidence after conflicting social information in those subjects that did not switch to follow social information, by stimulus condition and social information treatment

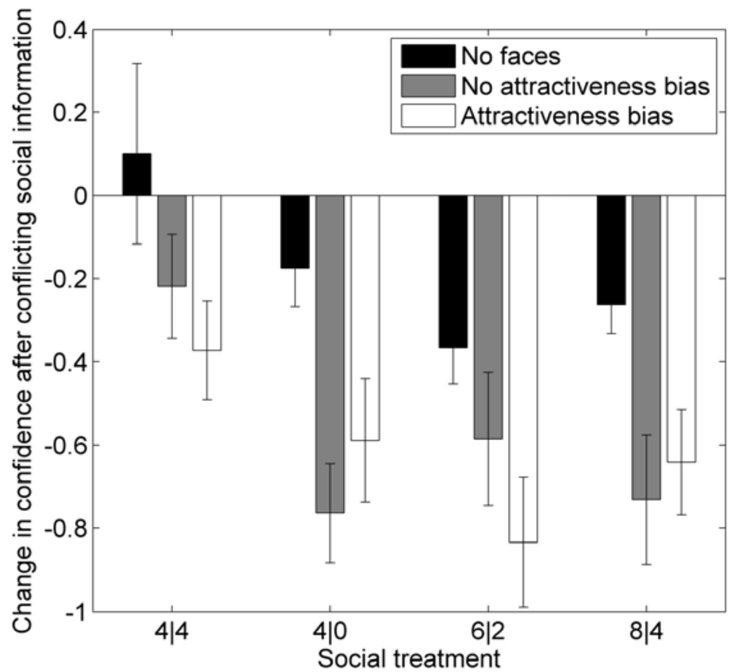

Table 3: Normal GLM results comparing changes in confidence to different social treatments by experimental condition (Beta gives parameter estimate, *p* gives significance)

	No face stimuli		Unbiased face stimuli		Attractiveness biased stimuli	
Treatment	**Beta**	***P***	**Beta**	***p***	**Beta**	***p***
4|4	Baseline	-	Baseline	-	Baseline	-
4|0	-0.2748	0.3180	-0.5449	0.0050**	-0.2154	0.2567
6|2	-0.4665	0.0914	-0.3662	0.0604	-0.4605	0.0176*
8|4	-0.3619	0.1882	-0.5120	0.0092**	-0.2686	0.1533

Table 4: Normal GLM results comparing changes in answer confidence within social treatments and across different experimental condition.

	No faces vs Unbiased faces		Unbiased faces vs Attractive biased faces	
Treatment	**Beta**	***P***	**Beta**	***p***
4|4	-0.0590	0.2134	-0.0425	0.3738
4|0	-0.0619	0.0019**	0.0468	0.3555
6|2	-0.0267	0.2345	-0.0492	0.2709
8|4	-0.0669	0.0040**	0.0216	0.6567

General discussion

We have strong evidence that the stimuli associated with the reception of social information affects the way in which this information is used. We set up a stringent test –

that to follow social information, a subject had to go against their own previous, and correct, decision, so we investigated directly the ability of social information to produce apparently maladaptive responses, in the sense of the answers being incorrect. We found that the presence of facial stimuli in the presentation of social information completely reversed a strong preference for consensus in social information, apparently causing subjects to prefer instead social information derived simply from more people. This, and the generally negative effect of facial stimuli on subject confidence compared to the *no faces* condition suggests that seeing other views specifically associated with faces produces some consistent loss of certainty in the subjects own judgement of the mental rotation task. Possibly, this is no more than the presence of eyes looking at a subject, which has been shown to influence people's degree of cooperation (Bateson *et al.*, 2006), making subjects more sensitive to some kind of 'judgement of the crowd'.

We found very limited evidence for any kind of attractiveness preference in the *biased faces* condition. This is surprising, given for example the pervasive use of attractive models in modern marketing. We intuitively expected attractive people to be more persuasive, but this is not the case in our experiment. This is not the result expected if the psychological mechanisms driving behaviours such as mate choice had been exapted directly to serve in the challenging task of making best use of social information. It argues in contrast that people are capable of filtering these biases out when assessing social information in specific domains. Perhaps we should not be so surprised at this result, because it is clearly an adaptive one – there is no reason at all that attractiveness *per se* should be particularly linked to ability at the kind of mental rotation task we used here.

Conclusions

- In the *no faces* condition, subjects were more likely to follow incorrect social information when it was associated with consensus (4|0>6|2>8|4).
- In contrast, in the *unbiased faces* and *biased faces* conditions, subjects appeared more likely to follow a majority opinion when it was associated with greater numbers of demonstrators (8|4>6|2>4|0).
- We could not detect any difference in response rates between the *unbiased* and *biased faces* conditions.
- Our results suggest that people alter the way they use social information dependent on the context in which it is presented. When associated with facial stimuli, subjects appeared to regard information from larger numbers of people as more reliable, even when there were relatively low levels of consensus.

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